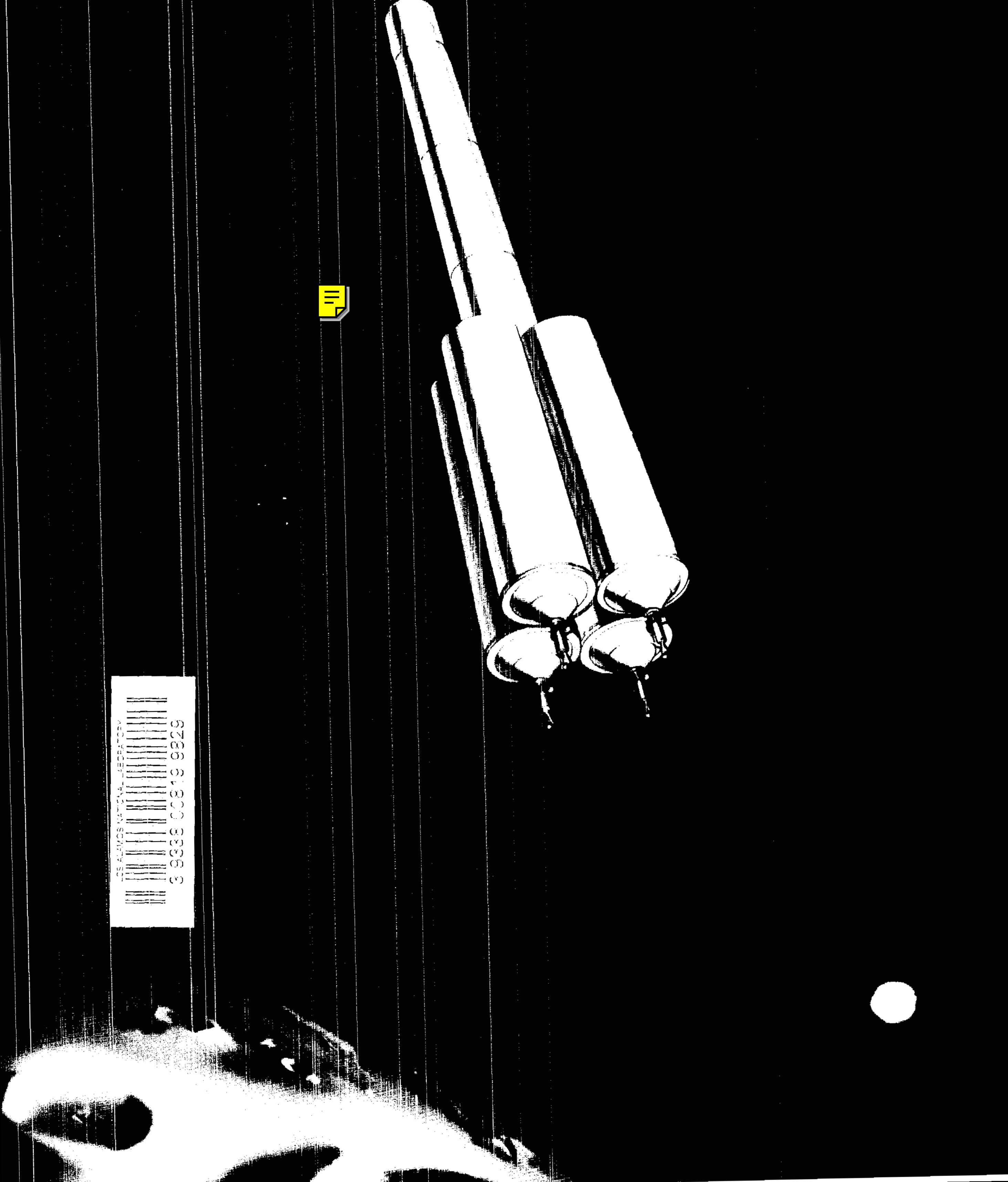
THE ATOM

Los Alamos Scientific Laboratory November, 1964



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ON THE COVER: A rocket of the future,
propelled by clustered nuclear engines,
passes near the moon on a voyage to a distant planet
in an artist's conception by Hal Olsen.
Work at LASL, leading to such an event,
is described in an interview beginning on page 4.

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an equal opportunity employer,
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Short Subjects

Darol K. Froman, former LASL Associate Director, will receive an honorary Doctor of Laws degree from the University of Alberta at Edmonton, Alberta, Canada, on November 7. The degree will be conferred at the University's Fall Convocation. Both Dr. Froman and his wife, who will also make the trip to Edmonton, received their bachelor's degrees from the University of Alberta.

Los Alamos Civil Defense Director Robert Y. Porton has requested that all persons whose fallout shelter status has changed within the past six months notify his office. Changes could include a new child in the family, change of marital status or home address, change of job or the acquiring of a skill which could be useful in case of a Civil Defense emergency. Information on changing shelter status may be obtained by calling 7-5456, or by going to room 139 in AP Building, the second building west of Ashley Pond.

LASL Director Norris E. Bradbury last month became the 1964 recipient of the achievement award granted by the New Mexico Academy of Science. The award, first made in 1962, is granted in recognition of outstanding work by a person engaged in scientific activity in the state of New Mexico. Dr. Bradbury, a native of California, is a graduate of Pomona College and the University of California. He received his PhD. in physics from the latter in 1932. He has been Director of the Laboratory since 1945. Bradbury, recuperating after hospitalization for virus hepatitis, was unable to attend the October 22 annual banquet of the Academy in Albuquerque. John V. Young, Public Relations Officer, accepted the award in his stead.

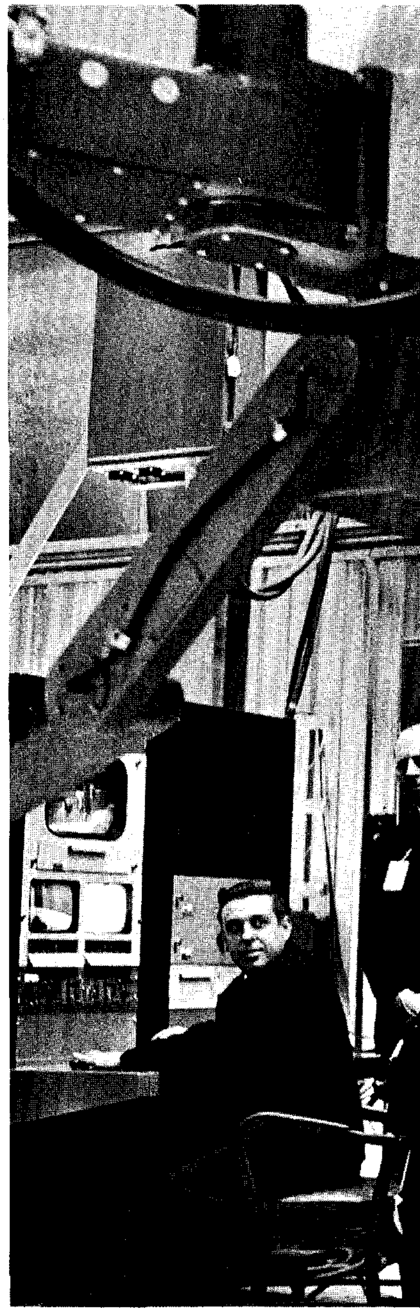
Gerold H. Tenney, GMX-1 group leader, is the 1964 winner of the duPont Award for achievement in the field of nondestructive testing. Tenney received the award, October 22, in Philadelphia, Pennsylvania, during the annual convention of the Society for Nondestructive Testing. He is a past president of the SNT. The duPont Award is granted to an individual who has made outstanding contributions to his profession through the use of fluorescent presentation or photographic recording of penetrating radiation.

Airborne fallout, apparently from the nuclear explosion in Red China, October 16, has been detected on extremely sensitive air sampling instruments at LASL, H Division, Leader Thomas Shipman reported. The level of radioactivity detected is far below that which should cause concern over health or safety, Dr. Shipman said. Similar increases in the radiation background were noted on instruments of the Sandia Corporation in Albuquerque and the New Mexico Department of Public Health in Santa Fe.

Los Alamos County will see a big growth in population during the coming year if predictions by the County Planning Department prove true. The department, which estimates the county's present number of residents at 14,200, foresees a population of 16,000 by the fall of 1965. Private home building, freeing government-owned dwellings for an influx of persons formerly living in neighboring counties, is the apparent cause for most of the growth.

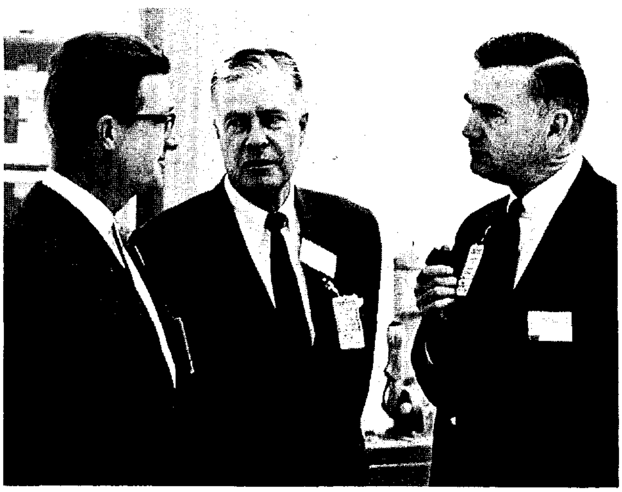
U. of California Regents, Officers Visit Laboratory

Vice President Wellman and Regents Treasurer Hammond (from left) hear about LASL operations from Technical Associate Director Raemer Schreiber.



At Ten Site, the University delegation was intrigued by the operation of Minotaur, super-manipulator developed for UHTREX. Seated at the control panel (left) is K-4 Engineer Robert Wiesener; standing (from left) are Regents Meyer, Heller, Hearst, Canaday, McLaughlin, Coblentz, Forbes, Vice President Emeritus Underhill and Regent Davis.

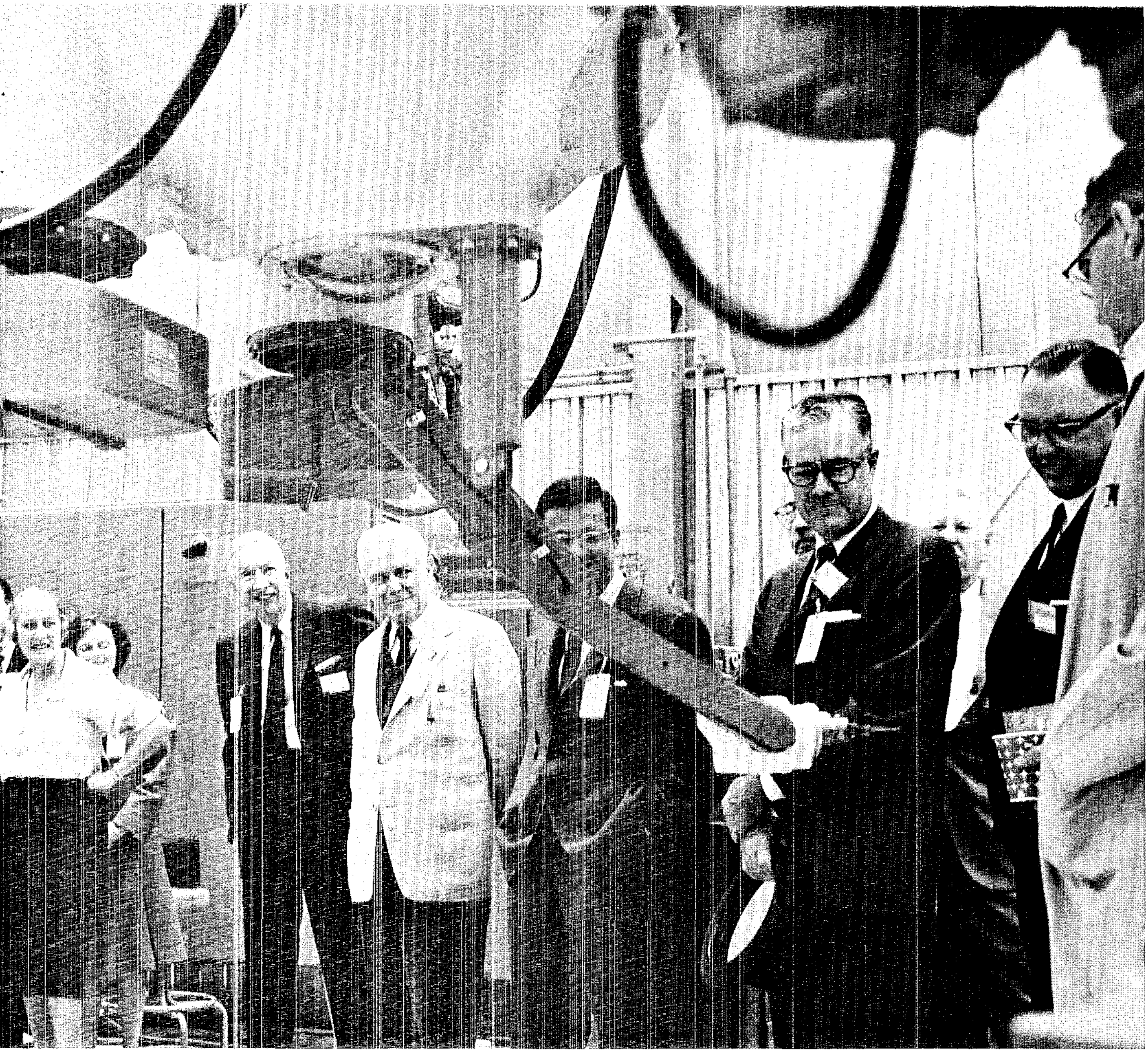
Reactor development was of great interest to the Regents. K Division Leader David Hall (left) discusses it with Regents Forbes (center) and Kennedy.



Nine members of the Board of Regents and three officers of the University of California were in Los Alamos October 30 and 31 for discussions with LASL Director Norris E. Bradbury and his staff and to visit technical sites.

It was the largest representation from the University since 1952, when the Board of Regents held a formal meeting at Los Alamos, which sometimes is called the "tenth campus" of the University.

The Laboratory has been operated by the University through contracts with the Federal Gov-



ernment since January 1943, first with the Army and, since 1947, with the Atomic Energy Commission. The present five-year contract extends to 1967.

In addition to their discussions and tours within the Laboratory area, the visitors had lunch with officials from the AEC offices in Los Alamos and Albuquerque, went on a bus tour of the community, and were taken through the LASL Museum in AP Building.

Included in the party were Regents Theodore R. Meyer and William K. Coblentz, both of San Francisco; Lawrence J. Kennedy, Jr., of Redding; Donald H. McLaughlin of Berkeley; William E. Forbes of Pasadena; Mrs. Edward H. Heller of Atherton; Mrs. Randolph A. Hearst of Hillsborough; John E. Canaday and W. Thomas Davis, both of Los Angeles; University Vice President Harry R. Wellman; Regents Treasurer Owsley B. Hammond, and Vice President Emeritus Robert M. Underhill.

The Laboratory's Role

AN INTERVIEW WITH DR. RODERICK W. SPENCE

Probably no LASL program is more widely heralded yet so little understood as the Laboratory's role in Project Rover. The true nature of the nuclear rocket propulsion program and its real objectives have often been overshadowed, even obscured, by apparent successes and failures of individual reactor tests.

THE ATOM feels that the following interview with Dr. Roderick W. Spence, N Division Leader and head of LASL's Rover research, does much to clarify LASL's place in the overall project. He discusses in depth a broad range of objectives, problems and plans and expresses many of his own opinions about Rover.

The interview was transcribed from a tape recording and is presented here almost in its entirety in its original question-answer form. Minor editing was done in the interest of clarity and to avoid repitition.

While it is somewhat lengthy, we feel it is rewarding reading for all who have an interest in the Laboratory and its programs.

Dr. Spence, would you discuss just where the Laboratory is today in the Rover Program? We understand that the Kiwi reactor phase has been completed and LASL will now go into what is called the Phoebus phase. But does this mean that we've reached some sort of Rover milestone? What is involved in Phoebus?

The fact is, there is no great break between these two programs. It's generally said that the last run, with the possible exception of the TNT experiment, marked the end of our Kiwi program, and the next reactor test that we run will be the beginning of our Phoebus program. But from the technical viewpoint, there is remarkably little difference between Kiwi E-301, the last reactor we ran, and Phoebus 1-321, which will be the first Phoebus reactor. They are, in essence, the same reactor.

What we will do is take the results from our previous tests and try to improve the reactor in a variety of ways. It's the beginning of the Phoebus program in the sense that we are trying to achieve Phoebus objectives. We want a reactor which will go to as high a temperature as possible. And we'd like a long life. And finally, it's always nice for space applications to have a low weight. We get low weight by having what we call a high power density; that is, for any given reactor volume, we want the power to be high—as high as is compatible with the other two objectives of long life and high temperature.

Now, what many people mean by "Phoebus program" is none of these things, but rather, the development of a larger and more powerful reactor.

in Rover

Nevertheless, we like to think of our Phoebus program as developing these three attributes along with a higher power reactor. Of course, all three attributes are good no matter what the size of the reactor.

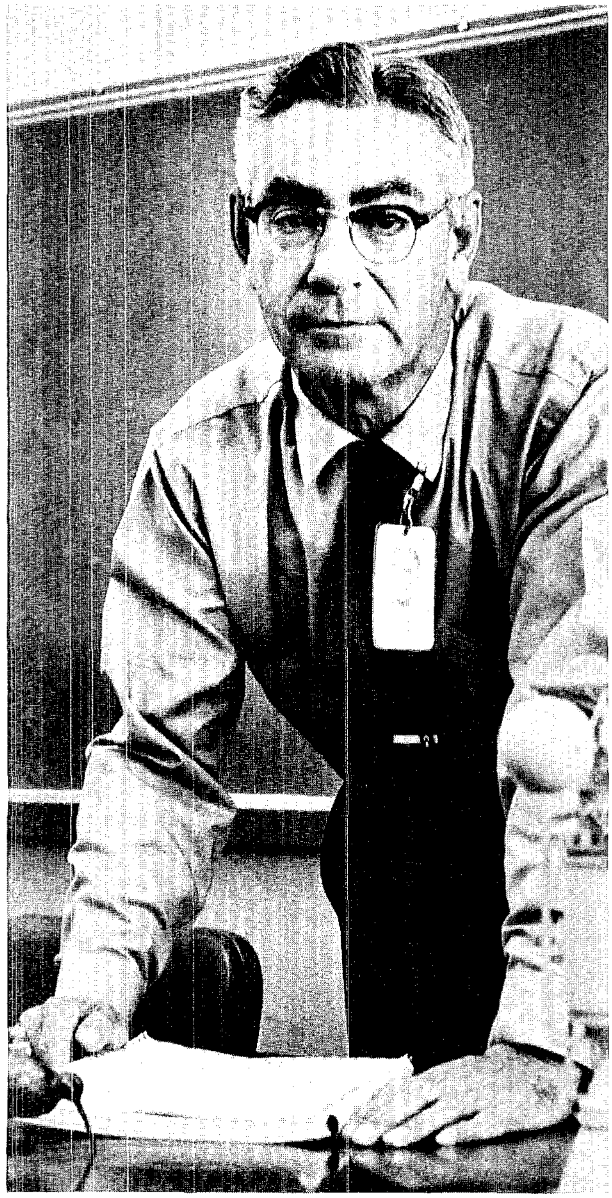
The size of the reactor is mission-oriented. I suppose it's fair to say that it isn't exactly known what the space program needs yet because NASA plans for further space exploration aren't that well firmed up. What we do believe is that the size we have picked for the next higher power reactor, which we call Phoebus-2, is of a size which is likely to be useful for future space missions. For Mars missions, particularly manned Mars missions, as an example of an advanced NASA goal, we would probably want to cluster nuclear engines rather than try to develop such a large reactor that it would be suitable for propelling a large vehicle from earth orbit into Mars orbit.

The recent successful test at Paraito Site of two Kiwi-type reactors run close together, then, in from what I gather, is a rather important experiment in the whole program. Is this right?

Yes, because it tells us that from a neutronic viewpoint, there is no block that we can see to clustering nuclear rocket engines. What it doesn't tell you, obviously, is anything about all the many engineering details that have to be licked in clustering engines. I think that most people would agree that clustering is a sensible approach. It is done with chemical rocket engines all the time. I doubt if there is any real reason why you can't do it with nuclear rocket engines. We have chosen a size and a power level for Phoebus-2 which we hope will be useful, both in clustered engines and in an individual engine.

Phoebus, then, is a more advanced reactor than what the NERA people are using now, and I assume that Phoebus will also be used by the NERVA contractors ultimately. Is this the plan?

I don't think there is an approved plan, but I suspect that your assumption will turn out to be right. I suppose the first question is: "Will the NERVA size reactor, the Kiwi-NERVA size reactor, be useful for NASA?" I don't know the answer to that. It has been suggested that it might be quite useful for lunar supply missions, if we establish lunar bases, and that the present reactor is worth developing into an engine for that reason alone. I suspect that NASA is considering this possibility. At the present time there is no approved program for completely developing an engine based on the



Dr. Roderick W. Spence was Alternate N Division Leader from 1955 until his appointment, three years ago, to head the Laboratory's nuclear rocket propulsion program as N Division Leader.

" . . . We're Primarily Looking for Answers. Sometimes the Answers Will Say 'Don't Do It That Way.'"

Continued from preceding page

Kiwi (and therefore, NERVA) reactor. Another possibility is to wait until the Phoebus-2 technology has been developed and then proceed with the engine based on that reactor.

The Phoebus-2 that you mentioned—you did say it would be larger than the thousand megawatt Kiwi-B reactor?

Yes. It's roughly in the 5,000 megawatt range.

Would you consider this reactor to be the ultimate in the heat transfer type of nuclear reactor?

Do you mean by that, "Would it be useful sometime to build an even bigger one?

That's right.

Possibly. It's very hard to say. The present belief is that if you can cluster a few of these you may never need to develop a bigger one.

We recently had a very successful run of the Kiwi-B4-E reactor in which the reactor was operated for eight minutes until it ran out of liquid hydrogen propellant and, I think 13 days later, the reactor was re-started. Could you tell me, one, the significance of the eight-minute run, and, two, the significance of the re-start?

For the first part, the signficance of an eight-minute run is tied up with the fact that we know now that reactors for space use are going to have to have lifetimes of at least 20 minutes. It is important that we can demonstrate that our reactor design and our reactor materials are compatible with a lifetime of at least 20 minutes. From the way the reactor behaved and from the post-mortem, I think we are very encouraged that 30 minutes is a reasonable goal for the reactors we're dealing with. The ultimate lifetime may well be longer but we feel quite hopeful that we can at least do that. Of course, we still have to demonstrate that we can run longer than we did in the B-4E test. But we're very encouraged. The basic reactor looks good.

The re-start is just something we have to do. For some time we won't have the hydrogen capacity at Test Cell C to get long-lived tests without having to interrupt the run to re-fill the hydrogen Dewars. So our reactors have to be able to cycle thermally. So far as the B-4E re-start was concerned, we didn't anticipate that anything bad would happen, but sometimes unknown things crop up. But apparently nothing bad happened.

About how long would a nuclear rocket engine be required to run in actual flight, say, to Mars?

I think there isn't any single answer to your question. It depends upon the year that you're attempting the Mars mission, on the weight of the vehicle you're trying to push, and on the nuclear rocket thrust—that is to say—on the thrust-to-weight ratio which determines the acceleration. Studies that have been made so far usually come out with running times of from 20 minutes to an hour, depending upon the details of the mission. There are at least three parts of the journey that nuclear rockets have been considered useful for. The first part of the journey, the toughest part as far as thrust is concerned, is starting from earth orbit and going close to Mars. Running times here with clustered engines rarely run more than 30 or 40 minutes. They could be as low as 20 minutes. The next job that has to be done for manned Mars missions—if it's not just a fly-by mission—is to go into an orbit around Mars, which takes energy. That probably would not require any more than a single Phoebus-2 engine, and the running times vary but again would be perhaps 20 or 30 minutes.

Finally, a nuclear rocket could be used to come out of Mars orbit on the first stage of return to Earth. And that is probably a comparable time, perhaps quite a bit shorter. It's rather seldom that nuclear rockets have been talked of for the last part of the journey, which involves landing on Earth. Chemical rockets are usually mentioned for that, for a variety of reasons.

We hear a lot about thrust in talking about chemical rockets. Is thrust as important a consideration in nuclear rockets as it is in chemical rockets?

Well, just about the same. The importance of thrust is that, even for orbit-to-orbit missions, you want to give your space vehicle some kind of reasonable acceleration. As a very rough rule of thumb, people don't usually talk about accelerations much less than about one-tenth G for so-called high thrust propulsion. There is another alternative: so-called low-thrust devices which give vehicle accelerations of a thousandth or even a ten-thousandth of a G. Nuclear-electric drives are this kind, where thrusts are very low and the running times are very long. I believe it is fair to say it's not known at the present time where the ultimate advantage lies—in high thrust devices or low thrust, very high specific impulse devices. Perhaps, in time, both will prove to be useful.

Project Rover met with some criticism during its testing phase, at least prior to this year. Do you consider some of the earlier tests successful even though the reactor runs were oftentimes cut short because of some sort of difficulties?

Yes, I do. Probably there is an inevitable confusion. We have always considered our integral tests in Nevada as just part of our research and development effort. They were truly eperiments. They were a long way from proof tests. On the other hand, it's awfully hard for people, particularly those on the outside, to view such experiments as anything but proof tests in which they want complete success. Naturally we like complete success too, but primarily we're looking for answers. Sometimes the answers will say "don't do it that way."

One of the clearest examples would be the B-1-B test. At the time we ran that test, we knew the reactor core we were using had serious deficiencies which probably ruled out that design as a serious contender for the NERVA engine. But the objective of that particular test was to find out the problems associated with liquid hydrogen startup and running the reactor with liquid hydrogen. We had never done that before. We, therefore, deliberately took a design which was not very good as a design, *per se*, but which was available and looked like it was good enough so we could start a reactor with liquid hydrogen and tell what troubles we were going to uncover. And we could save time by so doing. The design deficiencies didn't interfere with getting the information we wanted on the liquid hydrogen startup. From our standpoint, that was an extremely useful reactor test because it told us that a lot of the postulated problems of liquid hydrogen startup and running simply weren't there.

I think, generally speaking, that all of our integral tests in Nevada have had that one great virtue: they've told us what our real problems were—picked them out of a multitude of possible problems. And thus they've enabled us to go directly after what was blocking us. By the way, the last test, I think, did the same thing. Successful as it was, it pointed out areas where we can do fruitful work in order to extend the lifetime and increase the temperature. It will be a long time before we reach perfection.

Is LASL equipped to do rocketry work for nuclear rockets in addition to the reactors themselves? Might there be other phases—other problems—

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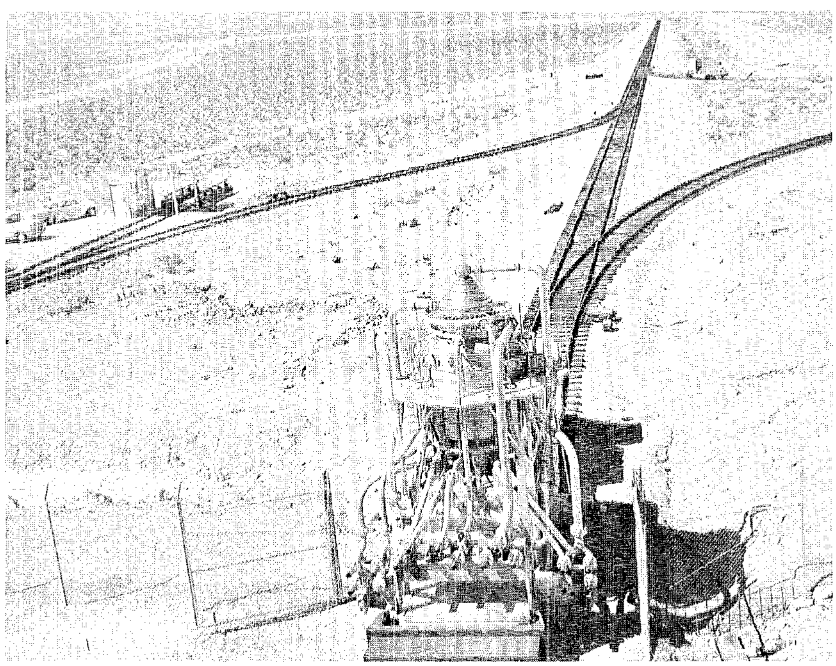

One of the Laboratory's first Kiwi reactors to be tested at the Nuclear Rocket Development Station in Nevada, Kiwi A-Prime, rests on its narrow-guage railroad tracks near Test Cell A.

"The Most Badly Needed Thing In th

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which this laboratory would be well equipped to work on?

We are not well equipped to develop a complete engine here. We are not experts in turbopumps or nozzle manufacturing, nor putting them together in a system. We probably are well equipped to tackle some phases of low-thrust devices. The plasma thermocouple work is a program which is aimed at that particular goal.

Did you read Senator Anderson's statement the other day that he's going to push for a mission?

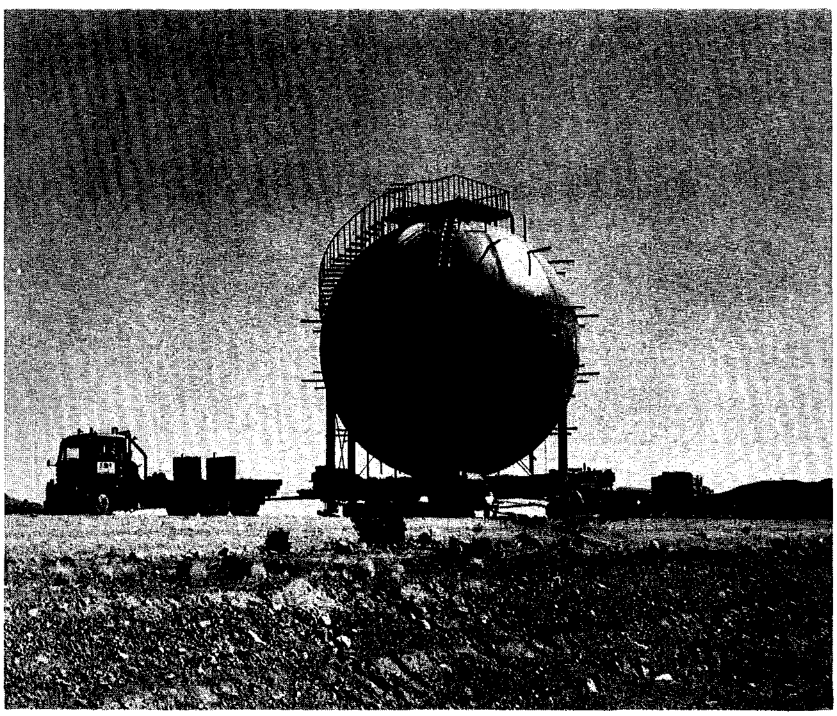
Yes, well, you almost have to have some such plan. Otherwise Rover can't go very far beyond just developing technology, which isn't horribly expensive and is a good thing to do. But as a major program, Rover must fit in with the rest of the NASA plans, it seems to me. Otherwise, there's not much you can do in the way of extending the work. At one time, it was thought useful to have as a goal just the demonstration of flight, an honest-to-goodness nuclear rocket flight. There doesn't seem to be much enthusiasm for that any more, although I myself think it has virtues. It may be too expensive. It would be better, of course, to be able to sharply define the engine that you need and how you're going to use it so that what you flight test for the first time is very similar to a useful configuration.

I suppose that the most badly needed thing in the Rover Program is a clear mission—one in which you can define what the engine looks like, what it has to do, how many minutes it runs and what its performance has to be.

In a way, all of this does not affect the immediate work that LASL is going to do in Rover. Our program, to a large extent, is almost independent of the NERVA work. All of our Phoebus work is the development of technology. Even in the absence of definite flight plans, or even in the absence of a definite engine development, everything we're doing is advancing the Rover technology. Going on to achieving higher temperatures, achieving longer life, achieving lower weight, extending these to a bigger reactor, are all largely independent of the exact future use in space exploration.

What is involved in making an engine out of the reactors we have now?

There are a few things that I know of specifically. We do not incorporate shields anywhere near the reactor, which presumably would be an integral part of a flight engine, particularly a shield between the reactor and the hydrogen tank. We don't



Duration of a Rover reactor test depends upon the storage capacity of liquid hydrogen propellant. Here, an additional 100,000-gallon Dewar is enroute to a test cell after being assembled at the MAD Building.

e Rover Program Is A Clear Mission"

try in any direct way to make sure that our reactor design will take the accelerations that flight will demand, although we don't believe our designs are incompatible with such accelerations. Nevertheless, it does take somebody to look and see whether the design details don't have to be changed to handle accelerations that you get in flight. In another area, flight control presumably is different than ground control, and there would be work to do here. But the major job is the development of a compact unit, including nozzle and feed system, which is capable of starting up in space and of running reliably for the desired lifetime.

What do our future test plans look like? When is the first Phoebus due; and then Phoebus 2?

We don't have all our plans firmed up yet. We're engaged in it now. We're thinking of trying another experimental reactor—the first Phoebus reactor—incorporating some changes that look desirable, probably not confined to a single change. We'll probably try quite a few things. Not all of them are going to work well. We're trying to see if certain changes, both design aand material changes, will be beneficial for future reactors. We would like very much to be able to get the results of that test by mid-summer, June or July at the latest, if we could.

Then it would be tested in late spring?

Yes, it would probably be tested in May or June. The biggest conflict here is trying to get all the experiments that we would like to do in on time.

That would be the first Phoebus. How about Phoebus-2?

The Phoebus-2 work is going along on schedule.

Then it looks like 1965 also?

No. We have never planned on a Phoebus-2 test that early. We're hoping for a Phoebus-2 test in the fall of '67, not '65.

Then you're going to have a long dry spell in testing?

No, I don't think so. We'll continue tests with the present sized reactors.

So you will be testing a number of Phoebus-I's.

Yes, we will. I don't know exactly how many. It depends a good deal on what time schedule we end up with for Phoebus-2. It is our present belief that the Phoebus-2 time schedule will be governed primarily by the nozzle development. Perhaps the turbopump, but probably the nozzle. There would not be much point in getting a reactor all built if we couldn't test it for a year, so we will have to gear our Phoebus-2 reactor schedule to the rest of the hardware. If we have to hold up because we know there will be a delay, it would be rather natural for us to continue our tests with the present size reactor.

The Phoebus reactors will, would you say, be higher power than the Kiwi reactors. What are these reactors going to look like? Are they going to resemble the Kiwi reactors? Will they be larger?

The Phoebus-2 reactor is a larger reactor than our present one. It will be larger in size and higher in power. We will attempt to increase the power density, that is to say, if it's twice the volume, we'd like to get more than twice the power out of it. Our experiments with the present sized reactor will not involve much increase in present power until we can get the necessary hardware that will enable us to run at higher power. First we'll try to increase temperatures somewhat, and lifetimes. And of course, try out various design schemes that might be particularly suitable for the Phoebus-2 reactor. But the general features of the reactors are the same. You asked, "Would they be similar?" Yes, very similar. The basic technology would not be very different.

Will you have as many people here at LASL working on the Phoebus program as have been engaged in the Kiwi program? Will there be an increase in personnel?

I think it will be at about the same level. No great change.

People in Nevada, then, are going to have plenty of work to do?

Continued on next page

"We Know How to Design Reactors . . . Our Basic Design Looks Good."

Continued from preceding page

Yes, because we will have a succession of tests. We would like very much to have about two tests at Nevada per year. That's the kind of a schedule that we find comfortable.

How long will LASL be involved in the Rover Program, as you see it? Is the Phoebus program, for instance, something that will be literally accomplished in, say, three years, four years?

Probably not, in that short a time. But it is true, that within at least a few years after that, I would say the basic work has been done. Of course, you never know what will be uncovered in the intervening years and it may very well be there will be some natural development that LASL will want to do. But at the present time we would think that the Phoebus work would end some time. It would not be as early as '67, but it could be as early as '70.

Well, is there some sort of obvious phase of work which will come along at this time or are we going to have to find an entirely new program in order to occupy the people now working on Project Rover?

I think we will have to find a new program. I don't think we would anticipate the present number of people working on solid-to-gas heat exchangers forever. So I think it means we must find new and interesting programs particularly suited for the Laboratory and its personnel. And, in fact, there are many people thinking about such advanced work already, but there is nothing that I can say about it.

Dr. Spence, one further thing. Would you summarize what has been accomplished by LASL up to now in the Rover Program?

I think we've achieved a level or plateau of performance which it was necessary to do before we could go very much further. This has not been any sudden thing, but rather the accumulation of the last eight or nine years of work in the Rover Program. We have, as an example, developed a good fuel element; we know how to design reactors; we know how to flatten the temperature so that it's possible to get a good high average temperature. Our basic design looks good; we know how to test these reactors in Nevada; we've learned how to deal with liquid hydrogen; we know how to control these reactors—meaning that we can control the power, the temperature and the hydrogen flow.

I don't mean to imply we have an optimum reactor as of today, not even in the present size. But I do think it is possible now to do optimization work. We aren't satisfied that our temperatures are as high as we can achieve. We're not satisfied our reactor lifetime is as high as we can get. But we know the directions to go. You asked earlier, "Was there any particular signficance in that eight-minute run?" There was one major significance: it could be done. We had a reactor which gave a good basic performance, and once having achieved that, it should be possible to do a lot more fruitful work.

The fuel element work, which takes almost a third of all the LASL people in Rover, has been a long development program, starting from almost gloomy prospects in the very early days, to the present high level of performance. If we had been faced in 1955, and even 1957, with the prospects of having to develop a fuel element which would last for half an hour, I don't know whether we would ever have started. We were thinking in terms of much shorter times in those days. Incidentally, we're now getting about to the stage in our development where it will be necessary to run reactors until we're forced to shut down, until something fails.

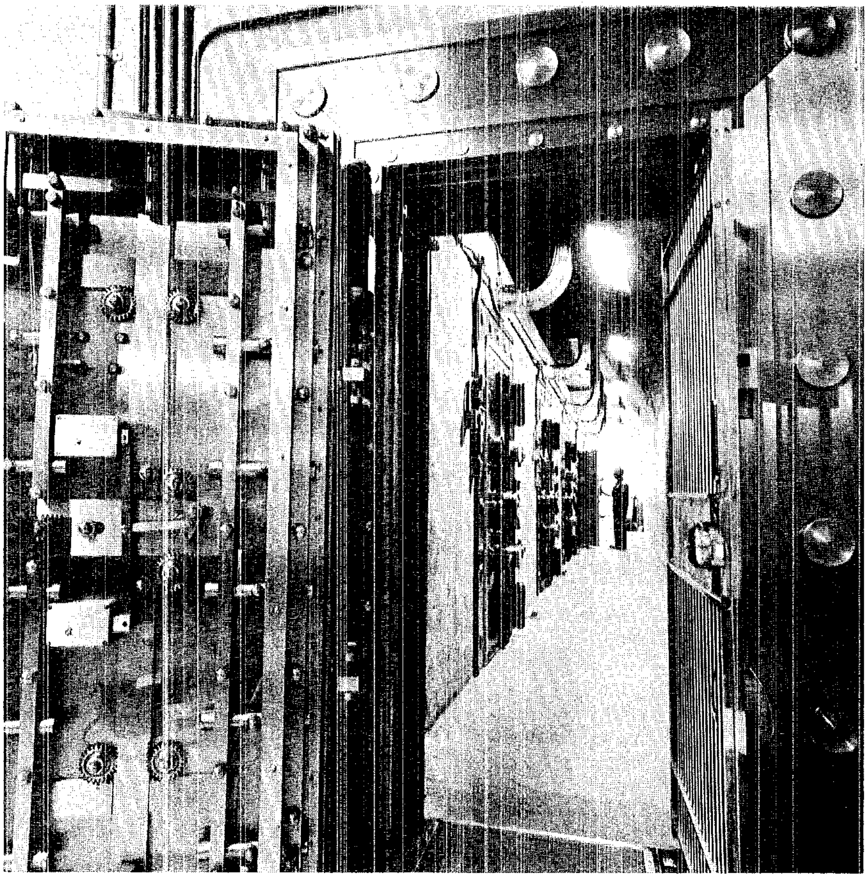
Yes, I think others have also said: If you can restart a reactor and run it again and again, it's a lot cheaper than building a new reactor each time.

Yes, and sometime, one wants to know, quite accurately: What is the weakest part of the system?

And the only way you can find out is to run it?

Keep running until something fails so badly that we have to stop. It isn't necessary that it be done with any particular reactor, but it should be done and done pretty soon, I think. It will be necessary in order to pinpoint the weakest points that we have to shore up.

Thank you very much, Dr. Spence.



Concrete walls and bank vaults provided ultimate security for storage of nuclear material in an unusual underground LASL facility built shortly after World War II.

THIS CAVE WITH BANK VAULT DOORS WOULD AROUSE ENVY AT FORT KNOX

LASL'S Unusual Underground Lab

BY EARL ZIMMERMAN

One of the Laboratory's least-known but most unusual installations is, literally, almost underfoot when you travel along Trinity Drive near the Zia warehouses.

It is a concrete-lined tunnel that pierces deep into the north face of Los Alamos Canyon, at TA-41.

No mere cubbyhole, the main tunnel can accommodate a large truck for nearly 250 feet of its length. The entire man-made cavern has a floor area of more than 6000 square feet.

The project that created the tunnel and its underground rooms was conceived during one of the post-

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Edward Macmann (left) and Walter Unger, both W-7 staff members, stand in the *main access passageway* that leads deep into a canyon wall at W Site.

Underground Lab . . .

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World War II crises that made evident the atom bomb had not banished the possibility of war. Needed was a larger, better-equipped and "safer" facility to replace the D Site Vault at TA-26, the blockhouse-like concrete building near the East Gate which was used for storing nuclear material.

The proposed new storage area was to be somewhat more sophisticated: Lined with reinforced concrete, equipped with three sources of electric light and power, modern plumbing, forced ventilation and air conditioning. Specifications called for a constant humidity of about 50 per cent and a temperature that remained between 40° and 60°.

Site location was a problem. It obviously should be in a cliffside, not far from the center of research, yet isolated and able to meet the most severe security standards. Further down Los Alamos Canyon was the reactor at Omega Site. Up the canyon was the road linking TA-1 and the residential community with outlying research areas. The bridge was not there yet. Further, Los Alamos Canyon was a favorite recreation area. Hikers clambered up and down the cliffs and padded through dense foliage on the canyon floor. So, in order to proceed with even semi-secrecy, the upper canyon was posted to advise all persons to keep out unless they had official business at Omega Site.

Rumors made the rounds nevertheless and there were tales in the cafeteria and Lodge about a great tunneling project that would make it possible to go from the new shopping center clear down to the mouth of Los Alamos Canyon!

The tunnel was designed by Black and Veatch, Kansas City, Mo., firm that did most of the planning for the "new" Laboratory that was to rise on South Mesa. Bids were called in the spring of 1948 and a contract was awarded to Brown & Root, Inc., of Houston, Texas. Construction commenced on June 1, 1948, and was completed exactly 51 weeks later. Cost of the tunnel and inner caves was $426,000. Outside appurtenances, including a double security fence, floodlights and a concrete portal and guard station raised the total cost to about half a million dollars.

Construction went surprisingly well, belying predictions from unsuccessful bidders and other "experts" that complications would break Brown & Root. (Other bids had ranged up to $657,000.) Once the tough shell of the cliff face had been penetrated, workmen found the salmon-colored tuff firm enough to require only a minimum of shoring and soft enough to permit excavation almost at the point of a shovel. Burrowing proceeded through the summer and fall, directed toward a point beneath the Non-commissioned Officers Club. By spring the concrete lining was all set and equipment was going in.

The diggings are shaped a bit like a crude key. The main passageway, which is wider than some *calles* in Santa Fe, enters through a huge steel door and leads to a suite of two rooms .The innermost chamber would arouse envy at Fort Knox. There are six shiny and massive doors—one for entry and five lined side by side—exactly like those in a bank. Multiple combination locks on each assure no one makes unassisted entry to this pentad of walk-in vaults. A spur tunnel leads from the main passageway to another large room that was designed for a diesel-powered electric generator, standby for service in case outside power was cut off. There is also an emergency battery supply for lighting.

Once the tunnel was completed it wasn't long until additional research facilities close by were desired, to eliminate the time and difficulty involved in transporting nuclear material to the laboratories and assembly areas on the mesa-top. The large two-story building that now houses Group W-7 was completed in 1951. A second building was added in 1959, for Group W-1.

(The W-7 building includes an experimental area which replaced the old stone Ice House that was on the edge of Ashley Pond. The original Ice House, obtained from the Ranch School when the Laboratory was established, was a hive of nuclear work. Oldtimers referred to the canyon replacement as the Ice House also, and it is listed that way in the telephone book. Several times each year W-7 staff members there receive the inevitable telephone call: "Can you deliver 50 pounds today?")

Today the "mine" is known to few outside W Division. It is still a security area, but most details of its construction were declassified in 1959. Although nuclear material is no longer stored there as before, this vast LASL basement is far from useless. The vaults are still used as vaults and security is just as strict as ever. But the long passageway and rooms are also ideal for pure physics experiments because of the rock-solid footing for light equipment and the excellent shielding afforded against natural background radiation.

There is another use that highlights an irony of science and history. Originally intended for the safekeeping of the stuff that makes man's mightiest weapons, the area is designated now as a shelter against the hazards those weapons create.

The familiar gold and black sign of Civil Defense is on the outer portal, and there are cartons along the arching concrete walls inside Shelter 41-004 containing supplies sufficient for two weeks for 219 people.

Picking piñon nuts is a family activity around Los Alamos, but a good crop comes along only once in two to five years.

A Story (In a

Don't sell the piñon short. Those funny looking dwarf conifer trees that grow around Los Alamos are important. They have provided man with food, fuel and shelter since he first set foot in what is now the western and southwestern regions of the U.S.

Growing on 25 million acres of land from Texas to California and from Idaho to Mexico, the piñon ranks first in commercial value among non-cultivated nut trees in the nation.

The harvest of its small thin-shelled nuts averages about a million pounds a year, most of it going to New York where the nuts are mechanically shelled and sold to candy makers. Good crops will yield up to 300 pounds per acre but they occur only once in two to five years.

The Colorado Piñon, which, despite its name, is the state tree of New Mexico, produces the best nuts. Also very tasty are those of the Single-leaf Piñon of the Far West. A third variety, the Mexican Piñon, produces an edible nut but with a hard shell that is tough to crack.

A commercial woodyard can do a good business simply by providing aromatic piñon logs for fireplaces, but the wood has also been used for

# of Piñons
Nutshell)

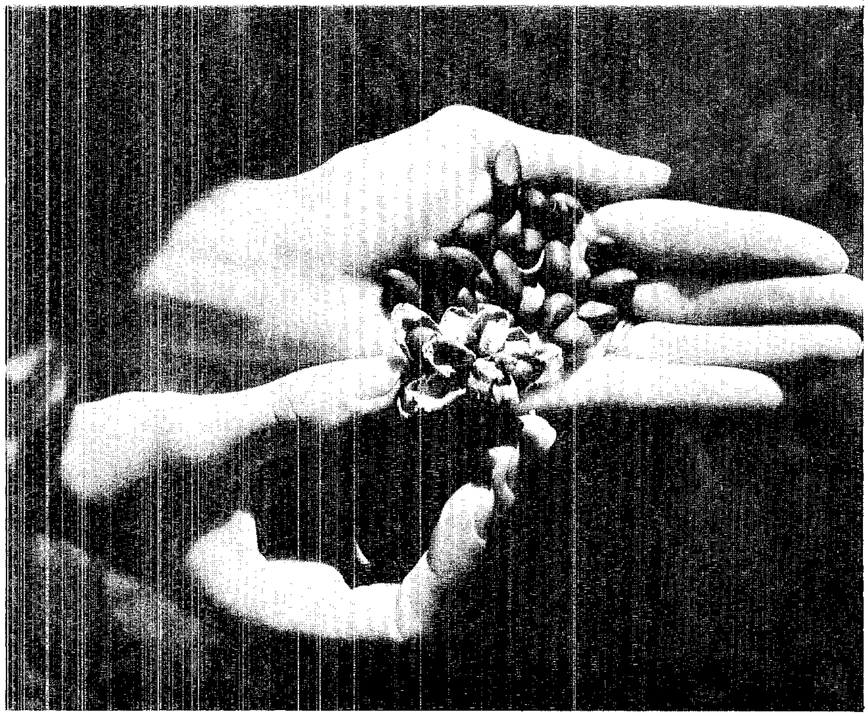
railroad ties, mine props, fence posts and the roof-supporting vigas of ancient Indian pueblos.

Incense, made from the crushed cones of the piñon, is used to scent candles or is burned in pellet form. Indians used the sap or pitch as a caulking compound to make water-tight baskets. The sticky stuff is a natural glue and is still used for cementing turquoise and other semi-precious stones into inlaid Indian jewelry.

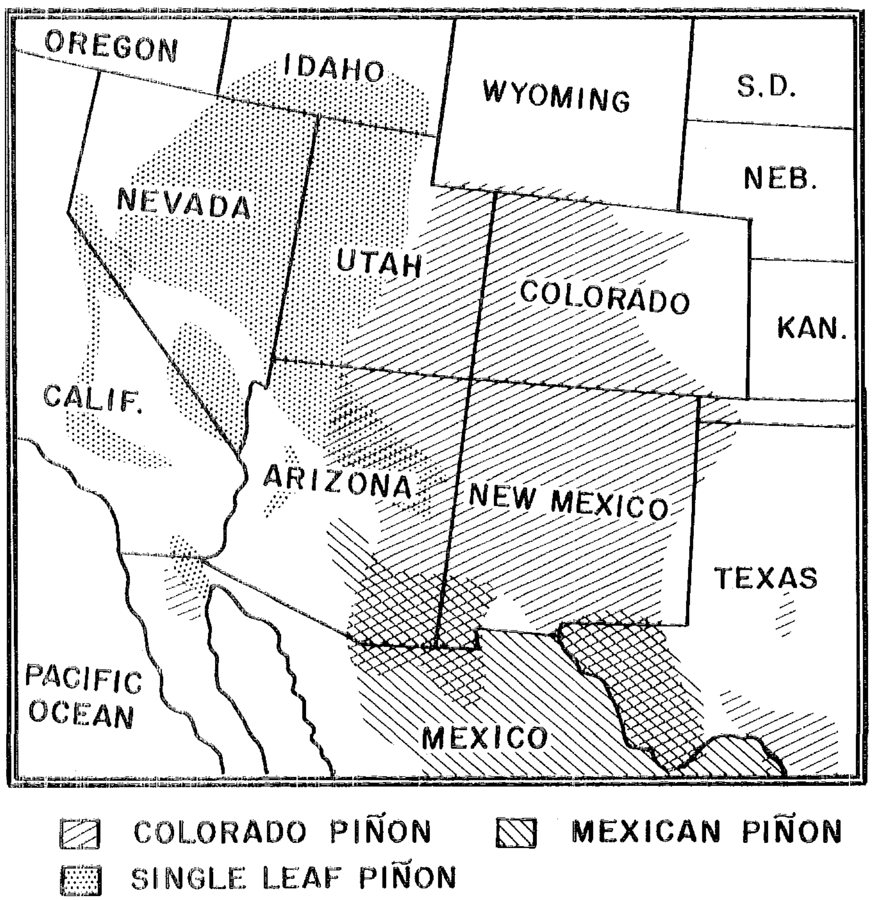
The trees seldom grow taller than 25 feet. Being shallow rooted, they grow best in rocky soils and thrive especially well in semi-arid regions at elevations between 4,000 and 9,000 feet.

Piñons are slow-growing but long-lived. Their trunk diameter may increase only a half inch in ten years but they needn't be in a hurry to grow because they can expect to live 300 or 400 years.

After centuries of helping provide men with necessities, the piñon has only recently assumed an esthetic purpose. It is becoming very popular for landscaping and has been transplanted successfully as far away from its natural environment as New England. A lot of people even prefer the piñon as a Christmas tree. Maybe its not funny looking after all.



As many as 30 piñon nuts are produced from a single cone. Below, a map of the western states shows the regions where the different species of piñons grow.



H-4's Marvelous Synchronized Cells

BY BARBARA STORMS

"I'm afraid it's going to be a while before we can build a Brigitte Bardot here in our lab," mourns Wright H. Langham, leader of LASL's Biomedical Research group.

Nonetheless, H-4 has plunged enthusiastically into a major program of cellular and molecular biology, fields of nearly limitless horizons which should some day provide man with enough understanding of life processes not only to overcome the major problems of genetics and disease, but ultimately to create living organisms to his own designs.

Once concerned primarily with effects of radiation on living things, the Health Research group has now shifted its emphasis to delving still deeper, studying the very fundamental processes of living cells to find out how and why living things are affected as they are.

"No real progress will ever be made in studying radiation effects or cancer without a clear understanding of the fundamental biochemistry of living cells," explains Cellular Biology Section Leader Don Petersen. To subject a cell with radiation or a potential cancer drug to see if it's killed or damaged "is like throwing rocks at a telephone exchange to find out how it works. It's just too crude."

To carry out the program, H-4 has been acquiring for the past year and a half, a corps of eager young PhD.s—microbiologists, virologists, and bacterial geneticists—who operate under the guidance of Alternate Group Leader Don Ott.

The first obstacle getting down to cell fundamentals is the growing of cells in an artificial medium in quantities large enough to permit significant biochemistry by conventional methods.

Since mammalian cells were first grown artificially, scientists have been able to use cells in tiny quantities a half dozen or so, to poke, prod and introduce various drugs and chemicals to study effects, or even to perform painstaking microbiochemistry by methods that may take months or even years to develop. For biochemistry by conventional methods, cells and their various components are needed in relatively huge quantities.

H-4 has achieved these quantities by growing cells in agitated suspension cultures in volumes up to 18 liters. Each liter produces about 600 million, or one gram of cells. The standard method, by comparison, is the monolayer culture in which a layer of about 1.5 million cells grows on the flat side of a small flask about the size of a vanilla bottle.

The scientists work with one line of cancerous cells from a human female and another from a benign tumor of a mouse, but are most interested in the normal cells from the ovary of a Chinese hamster.

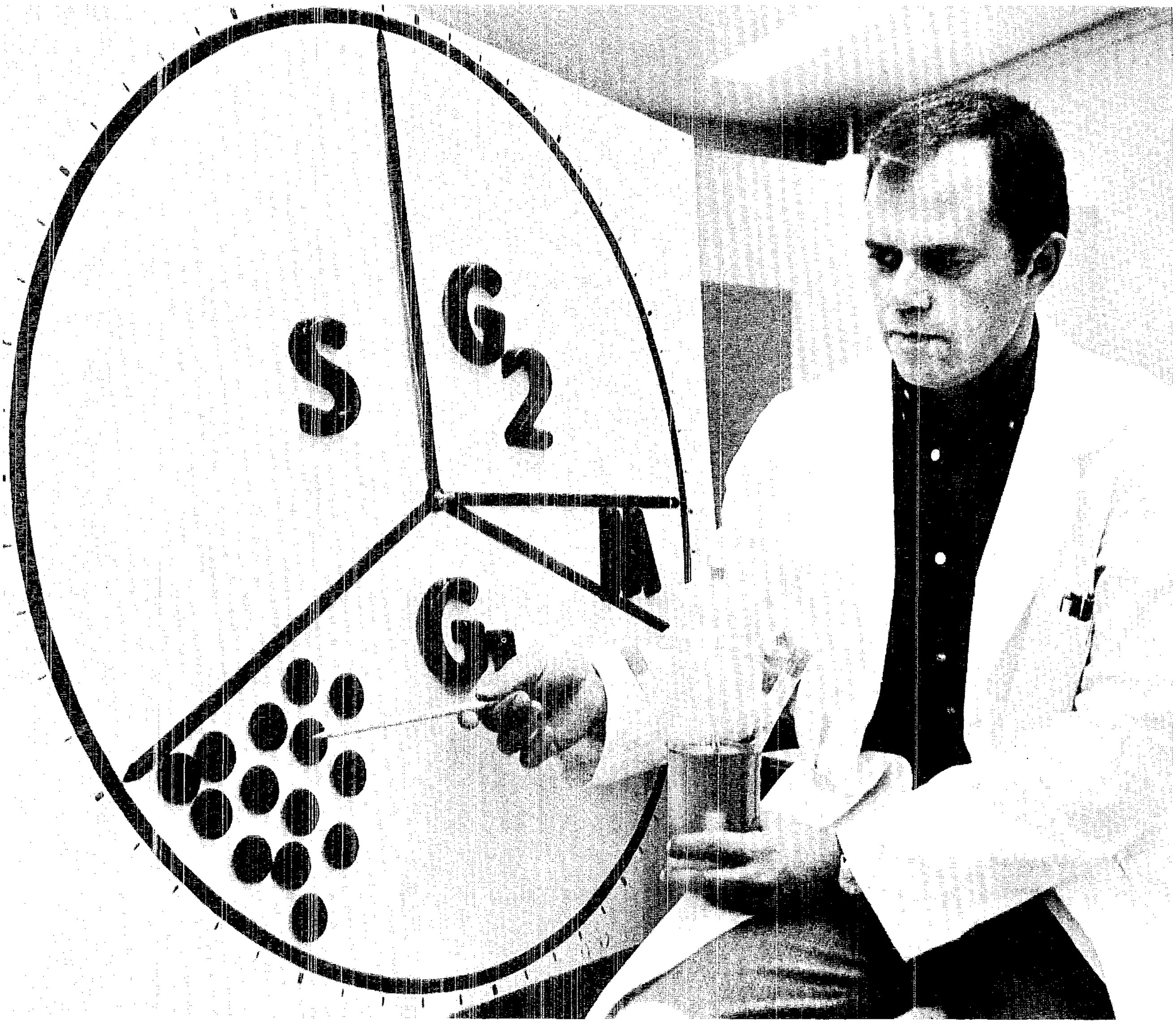
Once the large quantities of these cells are obtained, however, the researchers have little more than large quantities of confusion.

The life cycle of the hamster cell lasts from 11 to 14 hours, during which time it goes through three growth phases before dividing itself into two new cells. A test tube full of a few million cells, therefore, will include a conglomeration of cells in every possible phase of development. But what the researchers need to know is what is happening at precise moments in the cells' growth.

The key to the H-4 program, then, is the synchronizing of cell development and this laboratory is the first to achieve synchronized development in quantities of more than a few dozen cells.

To achieve the synchronized parade of the cells through their life cycles, H-4 scientists use what is called a thymidine block. An excess of the chemical thymidine, added to the medium in which the cells are growing, affects their ability to produce the critical DNA molecules and each cell stops growing at the time in its cycle when DNA production is to begin. Once all the cells have reached that point and stopped the thymidine is washed out of the culture and the entire cell colony proceeds through the cycle shoulder to shoulder.

In this orderly state of affairs, scientists are then able to pursue



Demonstration dial, shown by Section Leader Don Petersen, illustrates how cell populations are synchronized to go through life cycle together. Thymidine block temporarily stops growth of cells at "S" phase.

what they call sequential effects studies, confident they are pinpointing various cell activities at precise moments during development. They can, for example, learn exactly at what point various growth-stopping drugs take effect. Or by watching the progress of isotope-labelled materials required by a cell for its development, they learn just when the material is used. Enough of this sort of information eventually answers why these things happen and provides clearer understanding of the intricacies of cell development.

The H-4 program is also concerned with the mechanics of synchronization itself and the problems it provides. For example it now appears well-nigh impossible to keep cell colonies synchronized for more than four or five generations.

"Nature is bound and determined to keep these cells out of step," Petersen explains. It's easy to see why. Sequential effects studies have indicated that cells are affected by various trauma only at certain specific times. A virus, for instance, will enter and take over the operation of a cell early in the third phase of its development and stop division. Radiation, relatively harmless through much of the cell's life, is lethal in the few hours just before division. Synchronized, then, an entire colony of cells could be wiped out with one injury. In random growth, only a few cells would be hit at one time.

"It's a damn nuisance for us," Petersen says, "but it certainly makes sense for cells." Just how nature manages to throw this monkey

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Synchronized Cells . . .

Continued from preceding page

wrench into the scientific works is a subject for investigation.

Synchronization provides other problems, one of which is sleep.

"It's gone out of style here," Petersen yawns. "Synchronization experiments can last as long as 96 hours at one stretch. Those cells aren't on an eight hour day."

To overcome this problem Ernest Anderson is working on a method whereby a standard Coulter cell counter can be adapted to automatically sample, count and size several cultures of cells every four minutes around the clock, recording the information for well-rested scientists to study during more regular hours.

But sleep is not the only incentive for the effort. At best, hand sampling can be repeated only about once every hour; the researchers need precision.

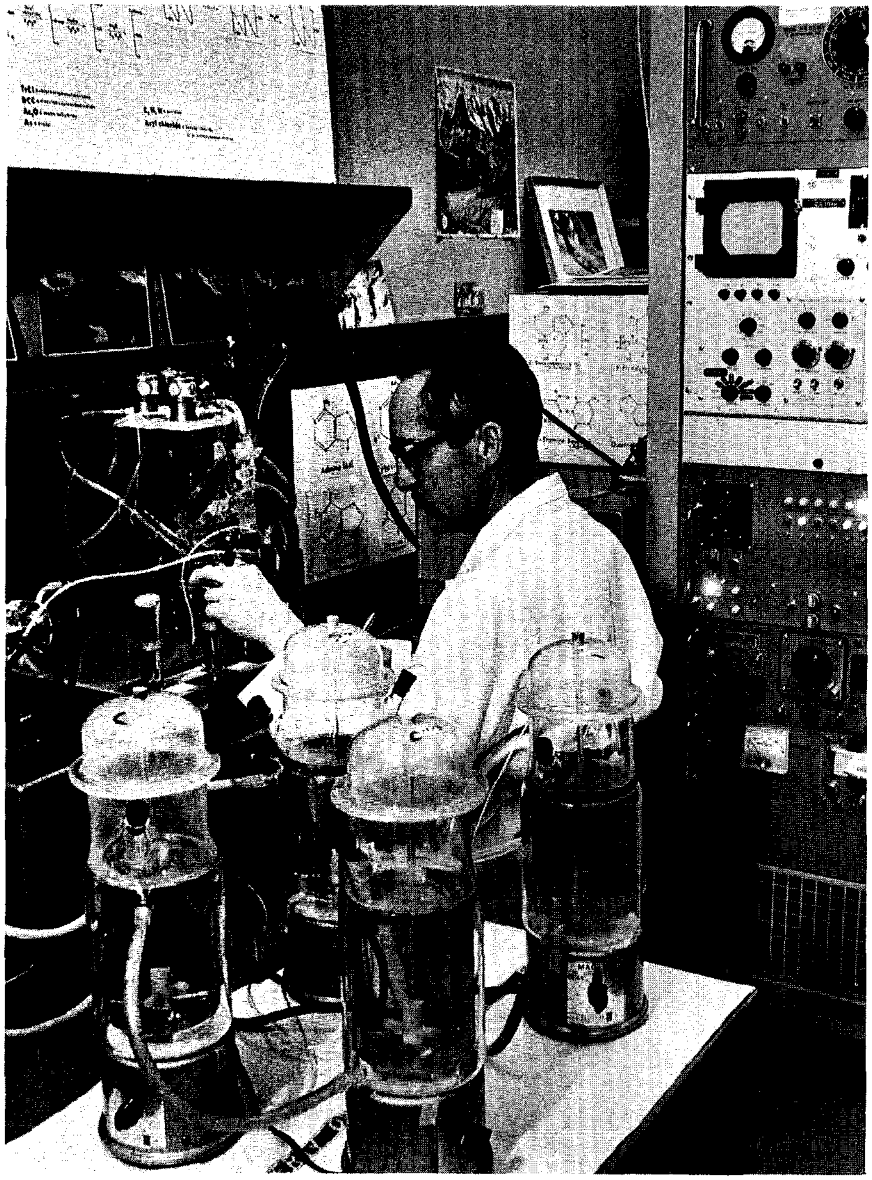
"We're trying to improve the precision so that we can come to within .2% of the same number in every measurement. So far we're only within 1%," Anderson says. "In our experiments we're interested in the very small proportions of the population, not the averages."

Anderson's big headache is the machine's over-long "memory" of previous samples. Little bits of the first sample will remain in the tubing which carries the cells from the culture to the counter and be recorded with the second sample. "We're trying to find a way to use small enough tubing to keep out the dregs and still be able to draw large enough samples to make it worthwhile."

The process of growing cells provides its share of technical problems as well.

The cells are remarkably persnickety about the food they eat, requiring a sort of witches' brew in which to grow. "We know the artificial medium must contain all the amino acids and vitamins, but there are a lot of other requirements nobody seems to understand," Petersen says. "Whatever they are, so far they've been found all together in serum of blood from unborn calves." With unborn calves hard to come by, commercial suppliers ask $26 a liter for the medium which adds up to a staggering $1000 to $1200 a month out of H-4's budget. "If cells would grow in bonded whiskey we'd save a lot of money," Petersen says.

The cells also require absolutely sterile surroundings at all times. Recently the laboratory inadvertently received contaminated serum and a month or so of work and many dollars worth of medium went down the drain. The lab has since inaugurated a system of cold sterilization for everything used in cell culture to prevent further disaster.



Ernest Anderson works at the problem of adapting cell counter to automatically sample, size, and count cell cultures every four minutes around the clock. Cells are mass produced in artificial medium in these spinner flakes.

They Found Awanyu's Gifts

LOCAL BOYS' DISCOVERY OF CENTURIES OLD POTTERY IMPORTANT ARCHEOLOGICAL FIND

The discovery in recent months of more than a dozen prehistoric pottery jars and bowls under the White Rock rim could have some dire repercussions, if ancient legends hold true and history repeats itself.

Many centuries ago, the legends say, drought devastated the Pajarito Plateau because Awanyu was angry with the people. Nobody knows now why he was angry; all they know is that the rains failed and the streams dried up.

Now if this happens again, one possible reason will be clear. Awanyu, the sacred plumed serpent-god, deity of sky and water, deity of springs and streams, has an obvious reason to be angry this time. The pottery bowls and jars that were pilfered from their hiding places were his property. They were placed there as ceremonial offerings to persuade him to lift the last drought.

It is not only that these gifts were taken away without so much as a by-your-leave or a pinch of pollen. All but one were empty, their original offerings of food long since claimed by the wild creatures. It was the sacred cotton in one jar, carefully covered by a bowl to keep it safe from intruders, that must have been particularly treasured by Awanyu. If Awanyu really is as angry as he has a right to be, this loss could prove to be the prime cause.

The pottery was discovered by Los Alamos high school boys and others during the past summer and into the late fall in small caves on

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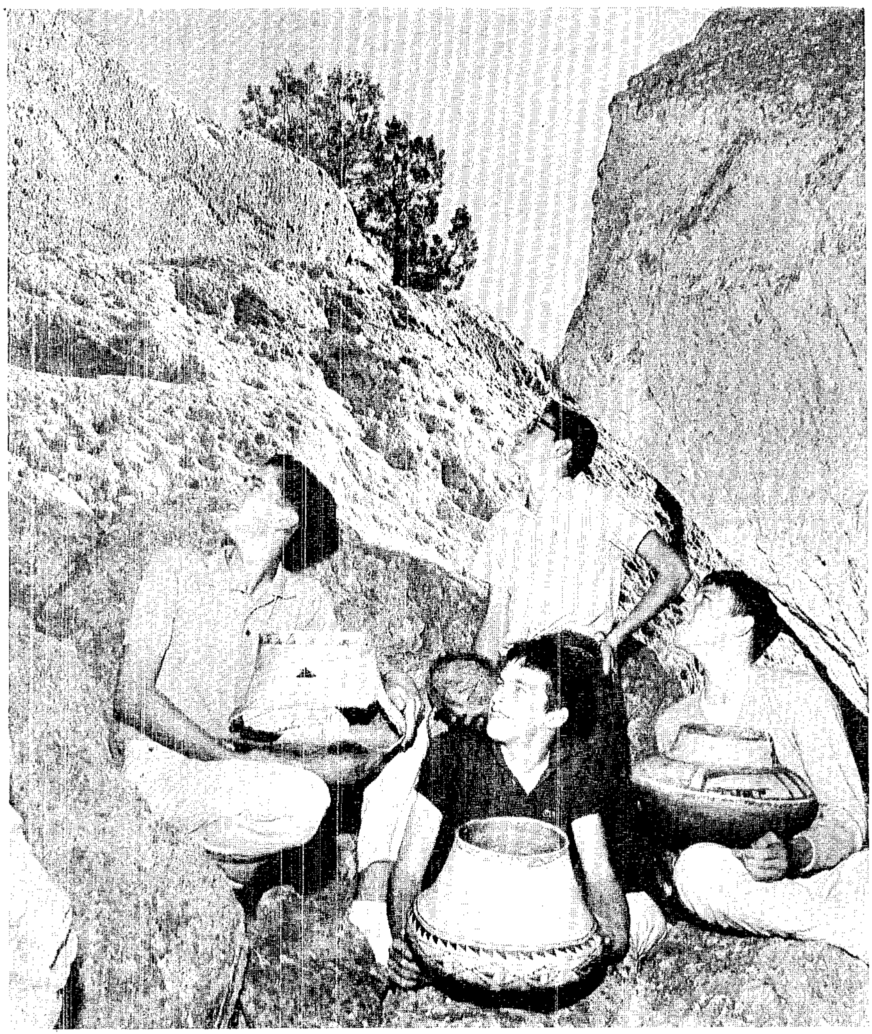


Four Los Alamos high school boys with some of the prehistoric pottery they found under the White Rock rim. It is believed the pottery may have been put there by Tewa Indians from Tiserge Pueblo as offerings to the rain god Awanyu centuries ago. Awanyu's eight-foot petroglyph (top left) adorns a cliff face overlooking Pajarito Road at Tsirege, near Highway 4. The boys are Conway Smith and Michael Burkheimer, above, John Marshall and Martin Hughes, below. (Photo by Bill Regan)

Awanyu's Gifts . . .

Continued from preceding page

the rough, steep and rocky west slope of the Rio Grande gorge at White Rock. At least 15 jars and bowls and one odd-shaped basket were among the reported discoveries. Nearly all were intact.

Three Los Alamos high school boys—Conway Smith, Michael Burkheimer and John Marshall—made their first find by chance in mid-summer, while poking around in the boulders on the talus slope under the White Rock rim. They saw what looked like the opening to a cave, and as only boys will—crawled in. There they found a unique prize—a large jar, decorated in the style known as Sankawi Black-on-cream (circa 1550), filled with unginned bolls of cotton, and covered with a bowl of the same ceramic type. Nothing like this had ever been found before in this region.

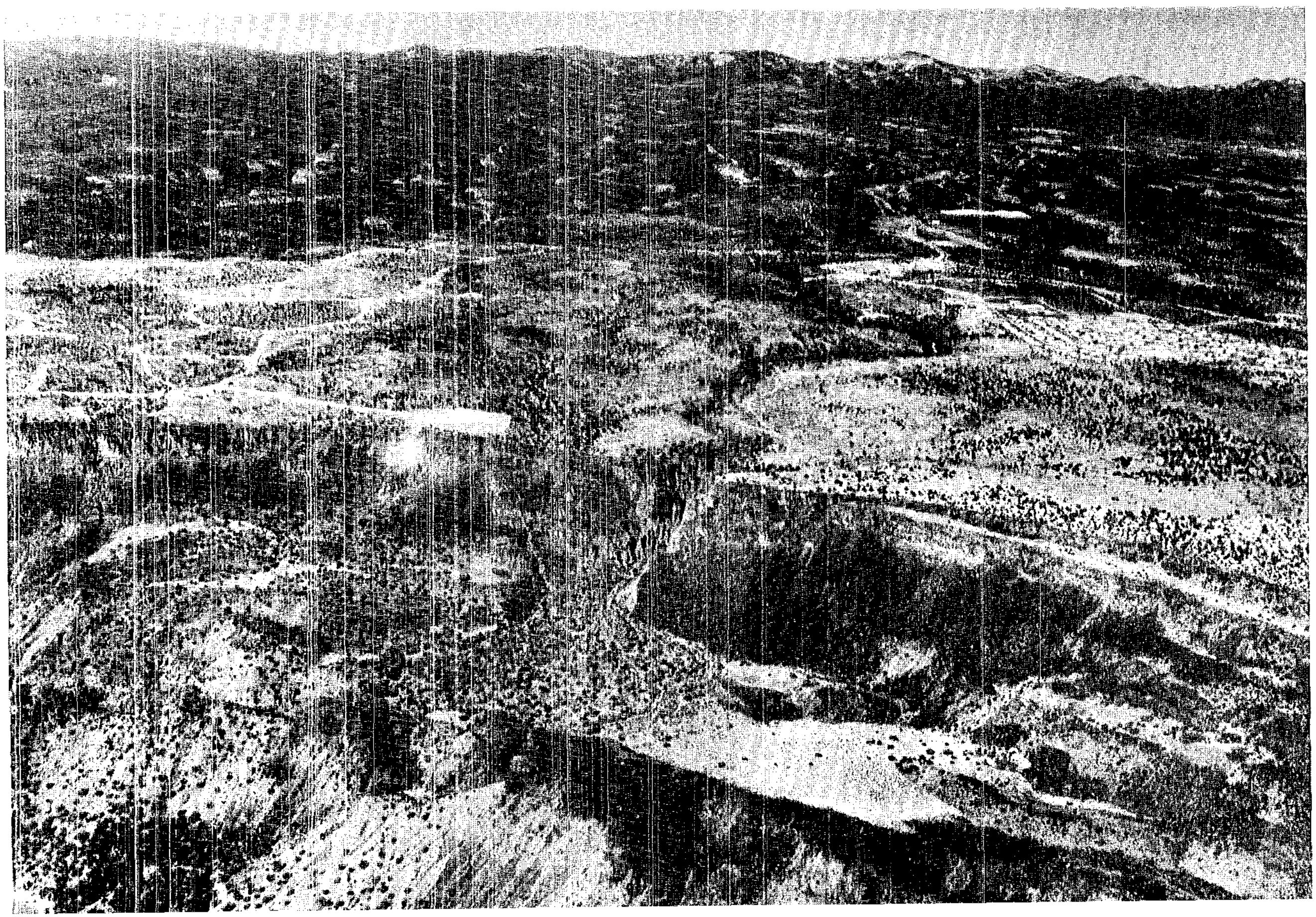
On four succeeding trips, they found seven more pottery vessels and an unusual rectangular basket. The other bowls were of the types known as Wiyo Black-on-white (circa 1325), a late form of Bandelier Black-on-gray (circa 1475), and four were undecorated cooking jars of the same period.

Their discovery started a small stampede. Eugene Raub of Alamogordo found a fine, single bowl of the typical Sankawi Black-on-cream, John Chamberlain and William Hudgins of Los Alamos found two bowls of the same type lying together in a cave. Martin Hughes of Los Alamos found three jars and one bowl. Two of them are among the finest examples of Sankawi Black-on-cream ware (circa 1560) ever found. Another is a rare glaze-ware jar, decorated in red matte paint and black glaze, of the period around 1470. The fourth is a biscuit ware bowl, of late Abiquiu or early Bandelier Black-on-gray, dating about 1425. These were all resting in a shallow cave at the mouth of Pajarito canyon, where it drops off the plateau.

How does it happen that so many fine, unbroken jars and bowls were left in these small caves, evidently never occupied or used for any other purposes? There are many possible explanations, of which the following is just one. It fits a lot of the facts. It is known that at various times over a period of two or three hundred years around the time of Columbus, Tewa Indian women from the mesa-top village of Tsirege went down daily to the Rio Grande a thousand feet below the rim of the Pajarito plateau, through the lands now occupied by White Rock and Pajarito Acres.

They went down to the river to get water, which they carried back to the pueblo in decorated pottery jars balanced on their heads. Sometimes they took along jars and bowls filled with food and other sacred offerings such as cotton to the water gods. They left these offerings in caves or niches in the rocks where the serpents, messengers to the underworld, could find them easily.

Aerial photo shows the rim of the Rio Grande where the pottery discoveries were made. Pajarito canyon is at center, Pajarito Acres to the left and White Rock to the right.



(The cotton supports the theory that the bowls were left for ceremonial purposes. Cotton has always been a sacred fiber to the Pueblo Indians, being spun by the men, not the women. The cotton, never cultivated in the upper Rio Grande, was imported from the south, from Cochiti or beyond.)

While water and life have always been synonymous in the Southwest, the situation was particularly grave during the period from about 1325 to 1550. Drought lay heavily on the land. The streams of the Pajarito plateau, intermitten at best, were failing. As the springs dried up, the women had to carry water greater distances, finally all the way from the Rio Grande itself, an arduous round trip of six rocky miles.

Without water, especially during droughts, the beans, corn and squash that were their only staple food could not survive, nor could the people. Understandably, the Indians were desperately willing to do anything they could to propitiate the gods, to placate the angry spirits who were denying them rain. The legends say that Awanyu, somehow offended by the people, withdrew himself from the earth, causing the springs and streams to fail. Then he threw himself across the sky, forming the Milky Way. (The Aztecs, who worshipped a similar deity called Quetzalcoatl, had a variant of this belief.) This is one reason, in all probalility, that the plumed serpent is often depicted in Pajarito Plateau petroglyphs in conjunction with an arc which may represent the sky, or the Milky Way.

So it was that the men of the tribe went down to the river also to add their ceremonial power to the gifts of the women. With vast patience and some stone tools (they had no metal), they laboriously pecked countless sacred designs into the smooth faces of big basaltic boulders. Some were quite obviously in the realm of sympathetic magic: an attempt to invoke the presence of deer, bear, rabbits and turkeys by drawing their pictures

Part of the result of a series of expeditions by Los Alamos high school boys and others is this collection of prehistoric pottery jars and bowls, all found in caves and niches under the White Rock rim. (Photo by Winfred Headdy)

repeatedly. (Some people see a resemblance to Madison Avenue techniques in this practice.)

Others were abstract symbols, some of them quite likely the signs for water springs. There were many, varied representations of Awanyu. One of the Southwest's best rock drawings of Awanyu, nearly eight feet long, guards the main access trail to Tsirege; there are scores of other such "pictures" of this all-powerful deity in the region.

The petroglyphs (and a few pictographs, paintings in red or yellow clay) have been remarked upon, photographed and sometimes mutilated by passersby. In recent years, most of them have come to be known to hikers, archeologists and others who prowl the old Indian trails and ruins. The hidden pottery stayed hidden for several hundred years, until this year.

Frank Harlow, T-3 group leader and local pottery authority, has examined all the vessels known to have been found and has written a report on them for the Museum of New Mexico. He thinks that all the later ones are from Tsirege. He dates them, from the style, shape and design, from around 1325 to as late as 1550 to 1570. He regards the discoveries as having considerable archeological importance.

The pueblo of Tsirege, which may have numbered 500 inhabitants at its peak, was built around 1450. Some of the lower caves probably were occupied earlier. The pueblo was finally abandoned between 1580 and 1600, about the time the Spaniards were establishing their first territorial capitol near San Juan. Water failure was the probable main cause of the abandonment. As further token of the ever-present water problem, Tsirege is one of the few old pueblos where a large reservoir is in evidence. There is no doubt something symbolic in the fact that a huge green-painted steel water storage tank to serve Pajarito Acres and White Rock has just been constructed by the AEC right next door to Tsirege, almost directly above the 8-foot petroglyph of Awanyu.

Now, if there will just be enough water to fill that tank, and keep it full. . . .

The Technical Side

25th University-wide Superintendents' Meeting, sponsored by University of California, Riverside, Oct. 1-2:

"Contract Maintenance at Los Alamos Scientific Laboratory, Los Alamos, N.M." by Charles A. Reynolds, ENG-4.

NASA Manned Space Flight Center Meeting, Houston, Texas, Oct. 2: (CLASSIFIED)

"Status of the Rover Program" by Keith Boyer, J-DO.

Meeting of Rio Grande Chapter of Association for Computing Machinery, Albuquerque, N.M., Oct. 1-2:

"Nonlinear Least Squares Optimazation of a Physical System" by Thomas C. Doyle, T-1.

"Overflow and Significance Problems in New Methods of Finding Roots of Matrices and Polynomials" by Zane C. Motteler, T-1.

"On Finite Difference Schemes for Laplace's Equation" by Neil M. Wigley, T-5.

"The S-C 4020 Microfilm Recorder at Los Alamos" by Glenn L. Carter, T-1.

5th Annual Symposium of Albuquerque Chapter of New Mexico Section of ASME, Albuquerque, Oct. 17:

"The Role of Neutronics in Rocket Reactor Design" by John Orndoff, N-2.

"Integral Reactor Tests in Project Rover" by Keith Boyer, J-DO.

"Analog Simulation of Kiwi Reactor Controls" by J. E. Perry, Jr., N-4.

The Electrochemical Society Meeting, Washington, D.C., Oct. 12-15:

"Surface Tension Determination from Frozen Menisci of Cobalt-Cerium-Plutonium Alloys" by John C. Biery, K-2, and J. M. Oblak, graduate student at Case Inst. of Tech., Cleveland, Ohio.

"The Reaction of Tantalum with Molten Cerium-Cobalt Alloys" by Felix B. Litton and John C. Biery, both K-2.

Lectures: Harvard University, Oct. 5; National Magnet Laboratory, Cambridge, Mass., Oct. 7; Mass. Inst. of Tech., Physics Colloquium, Oct. 8:

"The Use of High Explosives in Research" by Clarence M. Fowler, GMX-6.

10th Annual Bioassay and Analytical Chemistry Meeting, Cincinnati, Ohio, Oct. 8-9:

"Status and Application of Thermoluminescent Dosimetry Systems" by Edwin A. Bemis, H-1.

2nd Symposium on Protection Against Radiations in Space, Gatlinburg, Tenn., Oct. 12-14:

"Methods in the Evaluation of Radiation Hazards in Manned Space Flight" by D. Grahn (ANL) and Wright H. Langham, H-4.

19th Annual Instrument-Automation Conference, New York City, Oct. 12-16:

"Cryogenic Temperature Measurement in a Nuclear Radiation Environment" by Charles R. Tallman, N-4.

International Symposium on Insulation of High Voltages in Vacuum, Massachusetts Institute of Technology, Cambridge, Oct. 19-21:

"Experience with Back-biased Accelerating Tubes" by J. L. McKibben, P-9.

"Magnetic Analysis of Ions Involved in Current Loading" by J. L. McKibben, P-9.

17th Annual Pacific Coast Regional Meeting of the American Ceramics Society, San Francisco, Calif., Oct. 28-30:

"Radiation Damage to Alkali Halides and Other Simple Ionic Crystals" by Frank E. Pretzel, CMB-3.

Nuclear Materials Management Meeting, Gatlinburg, Tenn., Oct. 19-21:

"Nuclear Criticality Safety Considerations in Transportation and Storage" by David R. Smith, N-2.

Eighth Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 6-8:

"Applications of the Electron Probe Microanalyzer to the Determination of Trace Constituents in Reactor Materials" by E. A. Hakkila, G. R. Waterbury, and C. F. Metz, all CMB-1.

"The Determination of Oxygen in Metallic Sodium" by K. S. Bergstresser, G. R. Waterbury, and C. F. Metz, all CMB-1.

"The Determination of Oxygen in Pyrolytic-Carbon-Coated Uranium Dicarbide Beads" by M. E. Smith, J. M. Hansel, and G. R. Waterbury, all CMB-1.

"The Separation of Europium from Fission Product Samples by Reduction with Lithium Amalgam" by J. Bubernak, M. Lew, and G. Matlack, all CMB-1.

24th National Convention of Society for Nondestructive Testing, Philadelphia, Pa., Oct. 19-23:

"The Establishment of a Neutron Radiography Program at the LASL" by Bruce L. Blanks and Roger A. Morris, both GMX-1.

"Autoradiography of Fuel Elements of the KIWI Reactor, An Experimental Nuclear Rocket Engine" by Genevieve F. Wagner, J-11; and Kerry L. Bahl and Gerold H. Tenney, both GMX-1.

JOWOG 16 Meeting, AWRE, England, Oct. 19-21: (CLASSIFIED)

"Sensors for Vela Satellite Launches 1, 2, and 3. Data and Results from Launches 1 and 2" by James H. Coon, P-4.

11th Nuclear Science Symposium, Philadelphia, Pa., Oct. 28-30:

"A Thermoelectric Control Apparatus for the Fabrication of Lithium Drifted Germanium Detectors" by John M. Palms, P-DOR; Arthur H. Greenwood and William L. Briscoe, both P-1.

"Transient Response of Solid State Detectors" by Arthur Hemmendinger, W-8, Myron G. Silbert, P-DOR, and Allen Moat, P-3.

American Physical Society Meeting, Chicago, Ill., Oct. 23-24:

"Thermal Neutron Capture Gamma-ray Spectrum from $U^{238}(n, \gamma)U^{239}$" by H. T. Motz, E. T. Jurney, and W. T. Ford, all P-2.

"Ionization by Energetic Silicon Atoms within a Silicon Lattice" by Allan R. Sattler (Sandia) and Myron G. Silbert, P-DOR.

"Neutron Polarization Experiments" by Roger B. Perkins, P-DOR. (Invited Paper)

Thermionic Conversion Specialist Conference, Cleveland, Ohio, Oct. 26-28:

"The Open Circuit Voltage as a Thermionic Converter Diagnostic Tool" by Daniel Wilkins, summer student in N-5.

"Electron Temperature and Ion Density Profiles in a Cesium Plasma Diode" by Walter Reichelt, N-5.

Health Physics Society and Industrial Hygiene Association Meeting, Colorado Springs, Oct. 29-31:

"Management Point of View of Industrial Hygiene and Health Physics" (Panel Discussion) by H. F. Schulte, H-5.

"A Review of Laboratory Hood Ventilation" by R. N. Mitchell, H-5.

"Technical Writing" by Helen M. Miller, H-5.

"Health Hazards Associated with Lasers" by James D. DeField, H-5.

"The Role of the Health Surveyor" by R. J. Miller, H-1.

EIVR-10 Atomic Weapon Research Meeting, Aldermaston, England, Oct. 19-23: (CLASSIFIED)

"Compatibility Testing of Adhesives" by F. W. DuBois, GMX-3.

"Preparation of Plastic Bonded Detectors for Nuclear Weapon Diagnostic Studies" by James S. Church and Pierre F. Hartshorne, both CMB-6.

"Fabrication of Teflon by Hydrostatic Pressing" by J. S. Church, J. K. Donahoe, and H. Sheinberg, all CMB-6.

WHAT'S DOING

LOS ALAMOS HIGH SCHOOL POOL: Fall schedule for public swimming. Adults 35 cents, students 15 cents.

Monday	7:30 p.m. to 9:30 p.m.
Tuesday	7:30 p.m. to 9:30 p.m.
Wednesday	7:30 p.m. to 9:30 p.m.
Saturday	1:00 p.m. to 6:00 p.m.
Sunday	1:00 p.m. to 6:00 p.m.

OUTDOOR ASSOCIATION: No charge; open to the public. Contact leader for information on specific hikes.

Sunday, November 8, Upper Crossing, Stone Lions, Bandelier Headquarters. Leader, Ken Ewing.

Saturday, November 21, Bandelier Headquarters, Alamo Canyon to Rio Grande; Frijoles Canyon back to headquarters. Leader, Bob Day

Saturday, November 28, Hondo Canyon. Leader, Ken Ewing.

FILM SOCIETY: Civic Auditorium. Films shown 7 to 9 p.m. Admission by season ticket or 90 cents single admission.

Wednesday, November 18, abbreviated versions of two films: "Triumph of the Will" (Nazi propaganda), and "Ten Days That Shook the World" (Russian propaganda).

A NIGHT AT CIVIC AUDITORIUM: with Maria Sophia Zeigner in Songs of Today and Yesterday. Civic Auditorium, Friday, November 27, 8 p.m. Admission, $2, proceeds to charity.

INTERNATIONAL FOLK DANCE CLUB: Open to the public. Meetings November 17, December 1, 8 p.m., Recreation Hall.

AN EVENING OF FOLK MUSIC (Especially for People): Southwestern Folksingers' Guild in conjunction with high school "Sing Sing." Friday, November 13, 8 p.m., Little Theater. Admission $1.

LOS ALAMOS CONCERT ASSOCIATION: Bernard Peiffer Jazz Trio, Tuesday, November 17, 8:15 p.m., Civic Auditorium. Admission by membership ticket.

One Hundredth Person To Get Degree Through LASL-UNM Study Program

William R. Daniels, a chemist in J-11, has become the one hundredth person to complete degree requirement work in the academic training program that is conducted by the Laboratory in cooperation with the University of New Mexico.

Daniels will be awarded his PhD. in chemistry at UNM commencement exercises next June.

A 1953 BS graduate of Iowa State University, Daniels received an MA in radiochemistry from Washington University in 1955. He joined the LASL staff in 1957 and promptly enrolled for courses in the Graduate Center. He was nominated for the advanced study program in the spring of 1960 and spent the 1960-1961 academic year on the UNM campus in Albuquerque.

Daniels' achievement as the one hundredth degree-winner prompted Ted Dunn, of Personnel's Orientation, Testing and Training Group, to take a look backward at the Laboratory's academic program.

Graduate courses were first offered for resident credit at Los Alamos in 1950, Dunn recalled, but 93 of the 100 degrees have been achieved since the establishment of the UNM Graduate Center here in 1956. There have been 18 PhD. or ScD. degrees earned, 68 MS or MA, and 14 BS or BA degrees.

Of the 18 persons who have earned doctorates through graduate study at Los Alamos, 14 are employed by the Laboratory today. Another, C. Gerald Warren, is a member of the chemistry faculty at Colorado State University and was a consultant to CMB-1 this past summer.

Ninety-eight degrees have been earned by LASL staff members. The other two: Ruth Bombardt, wife of John N. Bombardt, SD-1, a BS in biology, and Rudy Velasco, presently superintendent of the power and light section of the Zia Company's Utilities and Engineering Division, an MS in nuclear engineering.

The program has contributed greatly to stability in the Laboratory's professional work force, Dunn said. Of all staff members who have received degrees in the past 11 years, 72 per cent are still employed in research or engineering positions at Los Alamos. This is equivalent to an annual termination rate of less than 3 per cent. The rate for all employes for the same period has been 6 per cent, a very respectable figure itself compared with similar institutions.

Another benefit from the Graduate Center, Dunn said, is its use for offering refresher courses at the graduate level in subject areas supporting the Laboratory's technical programs. This is of particular value to PhD. staff members who wish to audit—attend classes but receive no academic credit—courses in areas affected by rapid technological change. It is one of the reasons for the Laboratory policy of 50 per cent tuition assistance for enrollment in audit status in academic training program courses.

Dr. Glenn A. Whan, associate professor in charge of nuclear engineering at UNM, is director of the Graduate Center at Los Alamos. He is now preparing a new curriculum basic to achievement of an MS degree in the seven subject areas served by graduate-level instruction. Required "core" courses will be offered in a cycle, making it possible to attain the degree in three or four years while in residence at Los Alamos.

NEW HIRES

John Dean Brant, South Bend, Indiana, SD-1.

Connie Rae Pyburn, Los Alamos, PER-3.

Edward Lee Bradley, Atlanta, Georgia, CMB-6.

Mary Helen Burns, Los Angeles, Calif., SP-LA.

Edwin Charles Dudziak, San Bernadino, Calif., GMX-3 (Rehire).

Barbara Jean Pollock, Los Alamos, J-10 (Rehire-Part Time).

William W. Clendenin, Pittsburgh, Pa., T-DOT.

William L. Jennings, Albuquerque, N.M., P-11.

Alfred C. Bateman, Albuquerque, N.M., J-7 (Rehire).

Charles Don Reese, Camden, Arkansas, GMX-4.

Donald A. Garrett, New Orleans, La., GMX-1 (Rehire).

Robert Ernest Smith, Las Vegas, Nev., J-17 NRDS.

Janice Elnora Shadel, Los Alamos, H-1.

Martha S. Canada, Los Alamos, T-DO (Rehire-Part Time).

Joseph G. Valdez, Dixon, N.M., H-4.

Henry Watt Tyler, Fowler, Colorado, CMF-9.

Arthur J. Hundhausen, Wausau, Wisconsin, T-12.

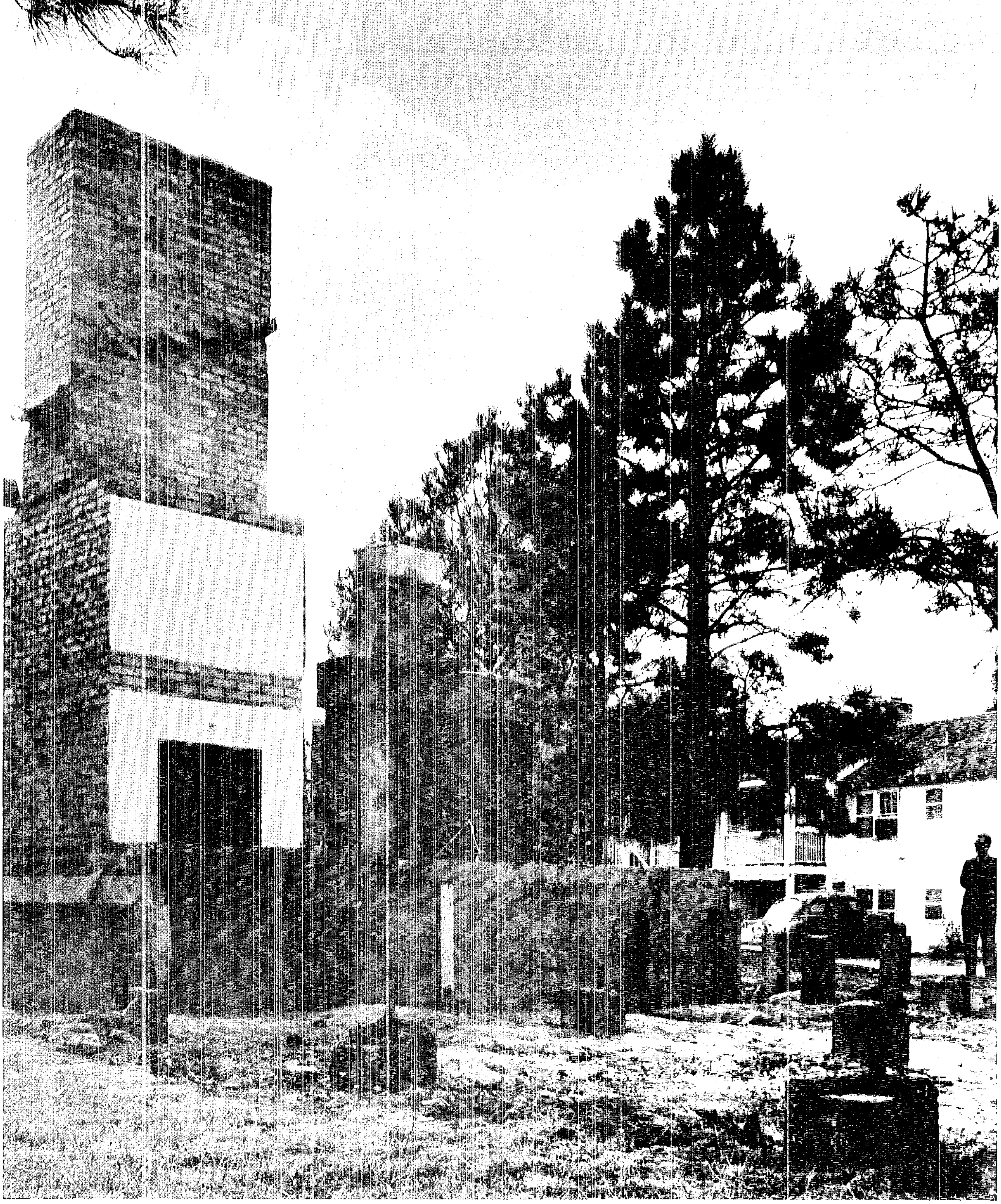
Dennis E. Smith, Albuquerque, N.M., N-5 (Rehire).

Larry Richard Ebaugh, Baltimore, Md., SD-2.

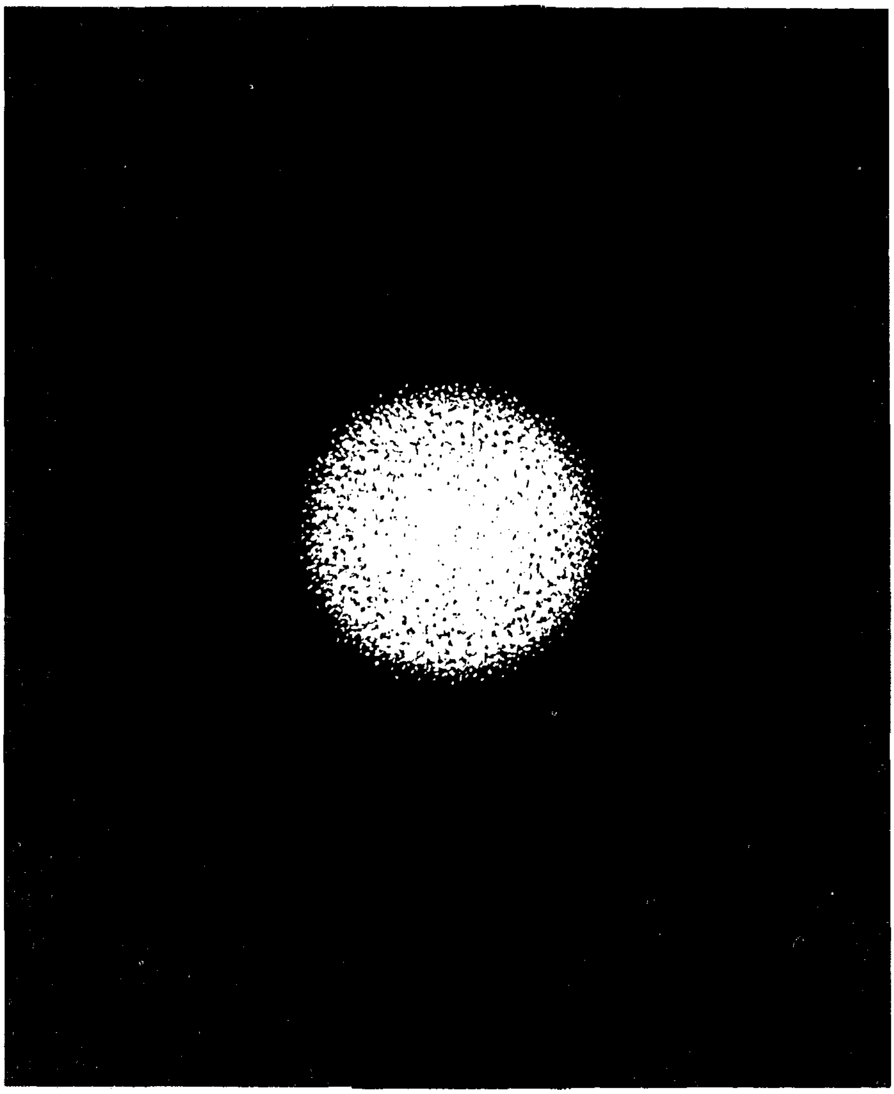
Mildred V. Hicks, Los Alamos, Bus. Off. (Rehire).

Randy C. Adams, Los Alamos, H-4.

John Armin Gerber, Idalia, Colorado, ENG-2.



Stark against the autumn sky, the chimney of a Sundt duplex symbolizes the beginning of the end of what 20 years ago was the elite housing at Los Alamos but which now is rated "substandard." The duplex, at 1380 23d Street, was the first Sundt to be taken out in a program that eventually will see removal of 326 units. The duplex and quadruplexes were sold on bid to the Los Alamos Transfer Company. Built in 1943 and 1944, the Sundts were home to most of the top Laboratory staff for many years. The Atomic Energy Commission expects at least half of the Sundt units to be vacant by January 1, 1965. Bill Regan's photo of the fireplace and chimney was taken after the frame duplex was cut apart and hauled on a truck to Espanola, where it will probably be reassembled and used again.



Artistic Interpretation by William Thonson

PROBLEM:
Plasma Containment

How to contain, for times $\sim$1/100-second at pressures of several hundreds of atmospheres, some deuterium gas which has been heated to temperatures $\sim$100,000,000° K., thousands of times higher than that at which all materials become vapor. This problem typifies the challenges faced by Los Alamos scientists and engineers in many areas of basic research.

Qualified applicants interested in research at Los Alamos are invited to send resumes to: Director of Personnel, Division 64-103

los alamos
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OF THE UNIVERSITY OF CALIFORNIA
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